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Issues Relating to the Use of De-icing Chemicals

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Abstract:	The report is a copy of a presentation on the issues involved in the use of salt and alternative de-icing chemicals. The purposes of the presentation were to summarize Ministry activities in recent years and recommend a Ministry position with respect to de-icing chemicals. The presentation contains background information on the following topics: 1) salt usage, legal precedents and environmental effects; 2) the financial implications, process technology, and results of field trials on CMA; 3) other alternative de-icers; 4) the use of inhibitors with salt to reduce corrosion damage; 5) the implications for the Ministry and for the municipalities of switching from salt to an alternative de-icer. The presentation makes several recommendations. Salt is identified as the de-icing chemical of choice until a technically and economically feasible alternative is available in the quantities required. The long term objective is to use a de-icer which contains neither sodium nor chloride ions. CMA is currently the most promising alternative. The effectiveness and environmental consequences of inhibitors are unproven.
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Issues Relating to the Use of De-icing Chemicals

* Salt
* Calcium Magnesium Acetate (CMA)
  - Financial Implications
  - Field Studies
  - Production
* Other Alternative De-icers
* Inhibitors
* Relationship with Municipalities
* Recommended Position

Salt

1977 Joint Statement from the Ministry of Transportation (MTO) and the Ministry of Agriculture and Food (M Ag F)

- reaffirmed use of salt
- no compensation to adjacent landowners
- research to reduce salt usage and mitigate its effects

1981 Ontario Supreme Court:
Schenck et al. v. The Queen
Rokeby v. The Queen

"There was no evidence that the quantities of salt used were greater than the essential task of keeping highways free of ice hazards, nor that the Ministry's maintenance standards were unreasonable, nor that salt was applied in a negligent way."

"Highway maintenance is an activity engaged in by the Ministry not for its own benefit but for the general benefit of the community. The Rylands v. Fletcher ductline, in my opinion, is not applicable to the factual situation of this case."

"The actions in nuisance must succeed. If as it seemed, such damage was unavoidably incidental to the use of salt in winter highway maintenance, fairness demanded that the loss be borne by the public generally, and not by the plaintiffs alone."

1987 The Director of Maintenance reaffirmed

- Ministry's winter maintenance strategy will consist of plowing plus the judicious use of sand and salt
- Research will continue

Current Position

Salt is the material of preference but in environmental effects

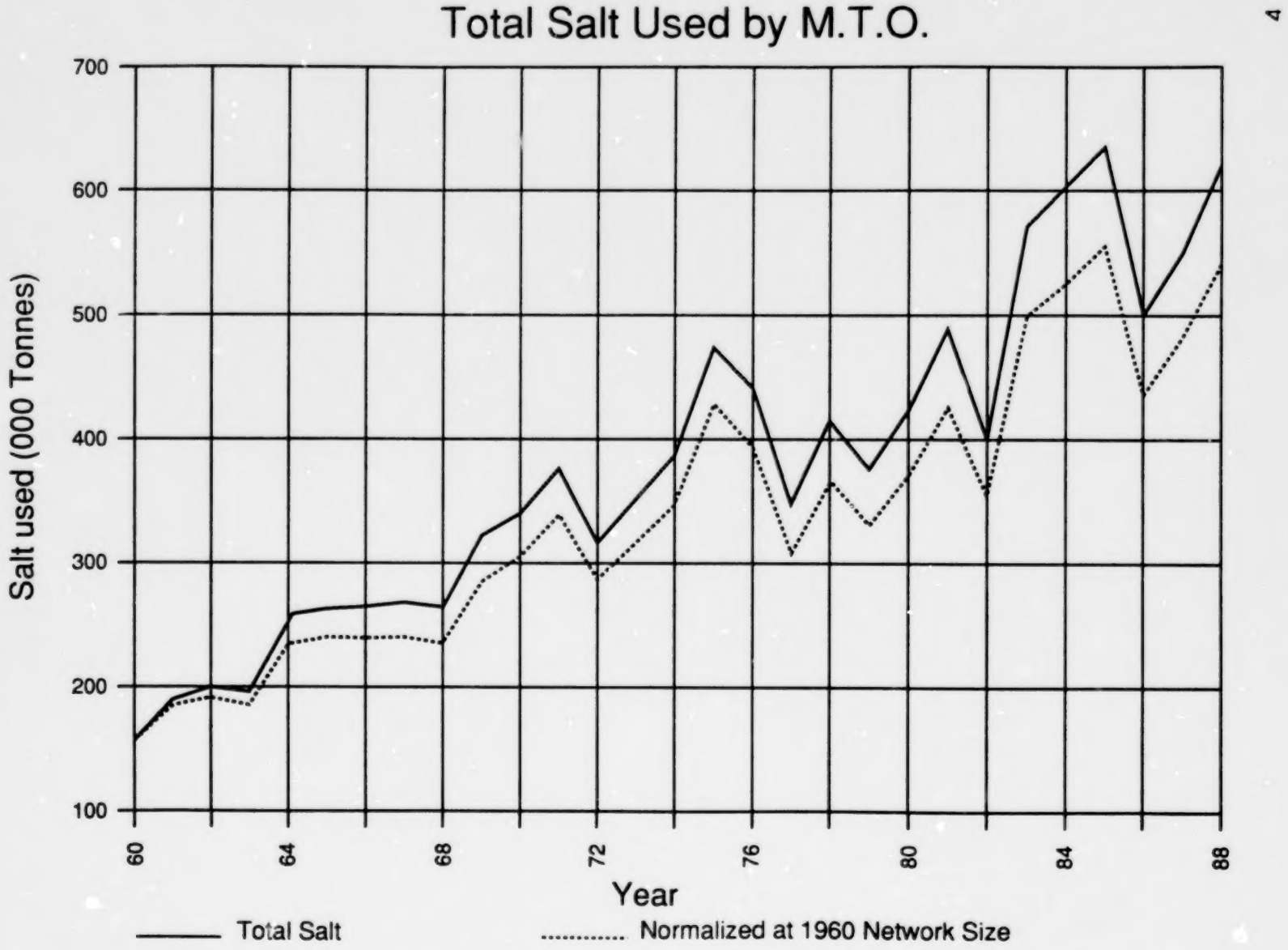
- vehicles
- structures
- groundwater
- vegetation

amounting to 10-20x the cost of material

1. Adopted maintenance standards and monitoring procedures to reduce salt usage while still maintaining acceptable service levels.

2. Seek alternatives:

   Long term objective is a de-icing chemical which is effective and contains neither sodium nor chloride ions.


Total Salt Used by M.T.O.
Salt used (000 Tonnes)
700
600
500
400
300
200
100
60
64
68
72
76
80
84
88
Year
Total Salt
Normalized at 1960 Network Size

CMA - Financial Implications

Environmental Costs of Salt

	%	$ Million/Yr
Vehicle Corrosion	75	677
Bridge Deterioration	8	72
Parking Garages	16	144
Groundwater	0.6	5.9
Vegetation	0.3	2.8

Break-Even Cost $400/tonne

1. Benefits are not realized unless a switch in all jurisdictions in Ontario.

2. Benefits accrue to individuals, costs to agency

   Additional Costs of Switching to CMA
   $900 million (at $400/tonne)
   MTO:Mun = 44:56

   Cost per adult $170/yr
   Savings per vehicle $139/yr

CMA - Field Studies

Is CMA a viable alternative to salt?

* 1986-87, 1987-88
  Burlington District (Winona Patrol)
  2.4 km section of QEW and adjacent service roads

  - Performance similar to salt
  - Application rate between 1.4 and 1.7 application rate of salt
  - Ratios of quantities used were 1.2 in 1986-87, 1.4 in 1987-88
  - CMA relatively more effective in longer storms
  - Storage and handling characteristics similar to salt
  - Minor changes in application procedures

* 1980-90
  Owen Sound District (Meaford Patrol)
  6 km section of Hwy. 26

  - Colder temperatures
  - Higher snowfall
  - Lower traffic volumes
  - 2 lane highway
  - Storage and handling

* Environmental Studies - elsewhere

* Cost: $500 U.S. per ton fob plant -- $1100 Cdn per tonne fob patrol yard

CMA - Production

CMA = acetic acid + dolomite

Research contract with Sheridan Technical Associates, Oakville (1 million tonnes per year)

Feedstock	**Natural Gas**	**Municipal Solid Waste**	**Corn Fermentation**
Capital Cost ($M)	880	1223	853
% Proven Process	94	46	25
% Carbon Utilization	72	55	29
Production Costs $/Tonne	303	341	530
Plant Location	S.W. Ontario (Sarnia)	Greater Toronto (Guelph, Niagara)	Not feasible
Notes	Gas trunk pipeline	6000 tonnes/day of MSW	30-45% Ontario corn crop

Other Alternative De-icers

* **Calcium Chloride**
  - used by some municipalities
  - more effective than salt at lower temperatures
  - pavement does not dry, icing situations in Ministry tests
  - tests in N. Ontario to improve adhesion of sand inconclusive
  - small scale test of 80-20 in Owen Sound 1989-90

* **Urea**
  - used at airports
  - not very effective
  - high nitrogen content
  - expensive

* **Sodium Formate**
  - City of Ottawa tests
  - contains sodium
  - not as effective as salt
  - more corrosive than salt

* **Freezgard & PCI**

Freezgard + PCI

Freezgard - magnesium chloride from Great Salt Lakes Minerals and Chemical Corp., Ogden, Utah

PCI - a lignosulphonate-based corrosion inhibitor produced by Georgia Pacific Corp.

Freezgard & PCI is a brown liquid containing 25% magnesium chloride and 5% PCI

Canadian supplier: Canadian Protective Products Inc.

Claims:
- acts faster
- reduces corrosion

Not aware of environmental tests

Material	Cost	Application Rate	Cost per 2-lane km
Salt	$35/tonne	130 kg/2-lane km	$4.55
Freezgard & PCI	$0.55/ litre	2 U.S. gal/1000 sq. ft.	$327
CMA	$1100/tonne	1.7 x 130 kg/2-lane km	$221

Possibility of substituting calcium chloride for magnesium chloride

Inhibitors

1. Effectiveness usually demonstrated in the laboratory under closed conditions.

2. Effect of dilution with time.

3. Possibility of separation of the inhibitor from the de-icer because of different rates of solubility.

4. Long-term effectiveness — most corrosion occurs in the summer months.

5. Environmental effects.

6. Effect of pH (concrete)
   * All previous research efforts have been unsuccessful.
   * A minimum initial concentration of 7% is needed (Bishop 1972).
   * The corrosive action of salt on mild steel is almost constant at concentrations from 10% to 0.05% solution.

MTO does not plan to test products which rely on an inhibitor to mitigate corrosion damage.

A very cautious approach is needed.

TCI

Domtar

Salt + 2.5% sodium monofluorophosphate

Claims — stops corrosion of steel in concrete

Environmental testing

- vegetation
- aquatic lifte
- mammals
- soils
- subsurface water

Relationship With Municipalities

1. Encourage initiative.

2. An urban environment is different from the rural environment.

3. A small number of well-designed investigations are much more useful than a large number of uncontrolled experiments.

   Two conditions for MTO subsidy:

   * An approved workplan
     - scientific validity
     - minimize duplication
     - range of parameters
   * A final report
     - proper documentation
     - shared benefits

4. Need a coordinating group — University of Toronto Institute of Environmental Studies?

Recommended Position

1. Salt will continue to be the de-icing chemical of choice until a technically and economically feasible alternative is available in the quantities required.

2. Initiatives to reduce salt usage and seek alternative de-icers will continue.

3. MTO does not intend to increase level of service with respect to winter maintenance.

4. MTO's long-term objective is to use a de-icer which contains neither sodium nor chloride ions.

5. MTO will give the highest priority to evaluating de-icers which do not contain sodium ions, chloride ions or inhibitors. Products which may lower costs, reduce salt usage or solve operational problems will be considered for testing, but at a lower priority.

6. The most promising alternative de-icer is currently calcium magnesium acetate. Initiatives to establish technical viability, improve process technology and evaluate the possibility of using municipal solid waste as a feedstock will continue.

7. Any switch to an alternative de-icer would necessitate co-ordination with municipalities on, at least, a regional basis.

8. MTO will encourage (with conditions) municipal trials of calcium magnesium acetate and provide the Municpal Roads Office with fact sheets on other products.